SUMMARY OF OPERATIONS AT THE CONOWINGO DAM WEST FISH LIFT FACILITY SPRING 2019

June 2019

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Prepared for

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EXECUTIVE SUMMARY

Since its operation began in 1972, the West Fish Lift (WFL) has been part of a cooperative effort to restore American Shad (*Alosa sapidissima*) and other migratory fishes to the Susquehanna River. In accordance with the restoration plan, the operational goal had been to monitor fish populations below Conowingo Dam and transport pre-spawned migratory fishes upriver. The operational goal has changed slightly since 2001, to collecting American Shad for spawning trials and egg delivery to Pennsylvania Fish and Boat Commission's Van Dyke Hatchery. Generally, the WFL objective is to collect pre-spawn alosines to monitor abundance, species composition, provide specimens for otolith analysis (monitor hatchery contribution of returning stock), and the collection of live, pre-spawn, adult alosines for tank spawning to support restoration stockings of larval alosines throughout the Susquehanna River Basin.

The start of operation for the WFL in 2019 began on May 1, 2019. The first American Shad (132) were collected on May 1. The WFL operated for 20 days in 2019 collecting American Shad for spawning trials and egg collection. The number of lifts in 2019 was 227 and fishing time totaled 124 hours and 20 minutes. A total of 227,724 fish of 31 species along with two Tiger Trout and one Striped Bass hybrids were collected and identified in the WFL sorting tank. Gizzard Shad (*Dorosoma cepedianum*) (220,110), Channel Catfish (*Ictalurus punctatus)* (3,136), and Common Carp (*Cyprinus carpio*) (1,128) dominated the catch, and comprised nearly 99% of the total fish collected. Gizzard Shad alone accounted for 96.7% of the total fish collected.

A new invasive species was identified at the WFL in 2019. The Northern Snakehead (*Channa argus*) was collected during WFL operations on 15 of 20 operating days. A total of eighty-one (81) Northern Snakeheads was collected at the WFL in 2019. Collected Northern Snakehead lengths ranged from 17 to 27 inches. All collected Northern Snakeheads were removed from the WFL sorting tank, euthanized and placed in the freezer at the WFL. These fish were provided to the PFBC for the purpose of collecting biological information.

The WFL collected 390 American Shad. The first 132 American Shad were collected on May 1, 2019. Collection of shad varied with 33.9% (132) of the shad collected on May 1, 51.0% (199) collected from May 1 to May 12, and 15.1% (59) collected from May 21 to May 31. The largest number of American Shad collected at the WFL in 2019 occurred on the first day of operation, May 1 (132). American Shad were collected at water temperatures ranging from 57.7°F to 75.0°F at Conowingo Dam's WFL and daily river flows between 40,700 and 76,600 cfs recorded at the USGS Marietta gage station. Of the 390 American Shad collected, a total of 185 males and 178 females were identified at the WFL in 2019. On the twenty operational days the male to female ratio ranged from 1:0.00 to 1:2.00. The highest number of male American Shad (50) was identified on May 1. The most female American Shad (55) identified were also collected on May 1.

A small number of river herring, (0 Alewife and 13 Blueback Herring) were collected during the 2019 season. One (1) Hickory Shad was collected in spring 2019.

This season, the WFL collected no American Shad that were previously captured, floy-tagged, and released downstream of Conowingo dam in 2019 by the Maryland Department of Natural Resources (MDDNR). This year, the MDDNR caught a total of 52 American Shad and floy-tagged a total of 43 American Shad.

Prior to the start of WFL operations in 2019, routine preseason maintenance activities were conducted, and included testing of the fish collection equipment (barrier screen, crowder doors, crowder, hopper hoist motor, and hopper door along with inspection of associated chain linkage, cables, etc.). These maintenance activities, along with routine maintenance activities performed in season resulted in no loss of fishing time due to mechanical failures during the entire fish collection

season. Future operations of the WFL will build on the past forty-seven years of operation experience.

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

1.0 INTRODUCTION

Exelon Generation Company, LLC, formerly the Susquehanna Electric Company (SECO), has operated a fish collection facility (West Fish Lift) at its Conowingo Hydroelectric Station since 1972. West Fish Lift (WFL) operations are part of a cooperative private, state, and federal effort to restore American Shad (*Alosa sapidissima*) and other migratory fishes to the Susquehanna River Basin. In accordance with the restoration plan, the operational goal had been to monitor fish populations below Conowingo Dam and transport pre-spawned migratory fishes upriver. The operational goal has changed slightly since 2001, now collecting American Shad for spawning trials and egg delivery to the Pennsylvania Fish and Boat Commission's Van Dyke Hatchery. Generally, the WFL objective is to collect pre-spawn alosines to monitor abundance, species composition, provide specimens for otolith analysis (monitor hatchery contribution of returning stock), and the collection of live, pre-spawn, adult alosines for tank spawning to support restoration stockings of larval alosines throughout the Susquehanna River Basin.

Objectives of 2019 operation were: (1) monitor collection of migratory and resident fishes at the WFL; and (2) conduct American Shad spawning trials for egg collection and delivery to Van Dyke Hatchery.

Since its operation began in 1972, the WFL at Conowingo Dam has been a cornerstone in efforts to restore migratory fishes to the Susquehanna River. The WFL operation provides the only source of Susquehanna River American Shad eggs for stock rebuilding initiatives. Additionally, the WFL provides otolith specimens for tracking hatchery contributions to restoration efforts, and providing fisheries independent data for reporting to the Atlantic States Marine Fisheries Commission (ASMFC).

2.0 CONOWINGO OPERATION

2.1 Project Operation

The Conowingo Hydroelectric Station, built in 1928, is located at river mile 10 on the Susquehanna River (RMC 1992). The powerhouse has a peak generating capacity of 549.5 MW and a hydraulic capacity of approximately 85,000 cfs. Flows in excess of station draft are spilled through two regulating and 50 crest gates. The powerhouse contains seven vertical Francis (numbered 1 through 7) and four Mixed-flow/Kaplan (numbered 8 through 11) turbines. The seven Francis units have been equipped with aeration systems that permit a unit to draw air into the unit (vented mode) or operate conventionally (unvented mode). The four original Kaplan turbines installed in 1964 were replaced over a period of four years (1992 to 1996), with more efficient mixed-flow Kaplan type turbines.

Minimum flow releases from the station during the spring spawning and fishway operating season follow the schedule outlined in the settlement agreement. Minimum flows of 10,000 cubic feet per second (cfs) or natural river flow (whichever is less), as measured at the United States Geological Survey (USGS) gauge at Marietta, PA were maintained for the period 1 to 30 April. A minimum flow of 7,500 cfs or natural river flow (as previously noted) was maintained for the period 1 to 31 May. A minimum flow of 5,000 cfs or natural river flow (as previously noted) is maintained when fish lift operations occur in June.

2.2 Fish Lift Operation

WFL operations are typically conducted during a 5-week period beginning in mid-April through late May. The start of operation for the WFL in 2019 began on May 1, 2019. The first American Shad (132) were collected on May 1 (Table 1). The WFL operated for 20 days in 2019 collecting

American Shad for spawning trials and egg collection. The number of lifts in 2019 was 227 and fishing time totaled 124 hours and 20 minutes (Table 2).

Operation times were planned during optimal fish collection parameters. This year, operational methodologies were influenced by natural river flow, water temperature, and generation. WFL operations were temporarily curtailed on 7, 8, and 9 May and from 13 through 20 May due to higher than normal river flow. WFL operation was conducted by a staff of four to five personnel: a lift operator, a supervising biologist, and two to three biological technicians.

The mechanical aspects of WFL operation in 2019 were similar to those described in RMC (1983). Fishing time and/or lift frequency was determined by fish abundance, and the time required to process the catch. However, two modifications to normal operation (first implemented in 1985 to maximize collection of American Shad (RMC 1986)) were utilized to reduce the large numbers of Gizzard Shad (*Dorosoma cepedianum*) attracted to the lift. First, operation "Fast Fish" (RMC 1986), which reduced the mechanical delays associated with normal operation of the crowder was deployed during periods of heavy fish activity. Second, the weir gate settings were adjusted and operation in the "Fast Fish" mode was continued until the accumulated fish were reduced. Normal WFL operation was resumed after the majority of fish activity was eliminated.

Attraction velocity and flow at the WFL were similar to those maintained since 1982 (RMC 1983). Hydraulic conditions were maintained in the area of the WFL between the crowder and weir gate entrances similar to that reported in RMC 1983. Modifications to weir gates and house service unit settings were made daily and during periods of heavy fish concentration and were similar to those reported in RMC 1986.

The specific entrance(s) used to attract fishes was dictated by the station discharge and which turbine units were operating. For example, when Francis turbine units 1 or 2 were operating, the downstream entrance was the primary entrance used to attract fishes. Under these conditions the attraction flow through the upstream entrance is negated or disrupted. This situation occurred seven times during the 2019 WFL season due to the higher than normal river flow this spring. On May 2, 6, 29, and 31 during WFL operation, both Units 1 and 2 operated the entire time. On May 3, Unit 2 operated the entire time during WFL operation. On May 11, Unit 2 began operating at 1430 hour until the end of WFL operations for the day. Lastly on May 1, both Units 1 and 2 were in operation at the beginning of WFL operations until 1200 hour. Depending on river flow, generation, and/or fish densities, the downstream entrance was primarily utilized throughout the 2019 season to attract fishes.

2.3 Fish Counts

Fish that were lifted and emptied into the sorting tank were identified to species and counted or estimated by a biologist and/or technician. All fishes were released back into the river, except for American Shad used for spawning trials and river herring species utilized for obtaining biological information.

Periodically throughout the day, fish collection data were recorded on data sheets and entered into a Microsoft Excel worksheet on a personal computer. Data processing and reporting were PC based and accomplished by program scripts, or macros, created within Microsoft Excel software. After the supervising biologist verified the correctness of the raw data, a daily summary of fish passage was produced and distributed electronically to plant and agency personnel. Each day's data were backed up and stored off site. Daily reports and weekly summaries of fish collected were electronically distributed to plant personnel and other cooperators.

3.0 RESULTS

3.1 Relative Abundance

Fishes were processed as reported previously (RMC 1983). The relative abundance of fishes has fluctuated at the WFL, primarily from species abundance, modifications to the lift and turbine operational changes. The number of fishes collected by the Conowingo Dam WFL is presented in Table 2. A total of 227,724 fish of 31 species along with two Tiger Trout and one Striped Bass hybrid were collected and identified in the WFL sorting tank. Gizzard Shad (*Dorosoma cepedianum*) (220,110), Channel Catfish (*Ictalurus punctatus)* (3,136), and Common Carp (*Cyprinus carpio*) (1,128) dominated the catch, and comprised nearly 99% of the total fish collected. Gizzard Shad alone accounted for 96.7% of the total fish collected. Greatest collection of fishes occurred on the third day of operation (May 3) when 25,483 fish, (over 98% Gizzard Shad), were collected.

A new invasive species was identified at the WFL in 2019. The Northern Snakehead (*Channa argus*) was collected during WFL operations on 15 of 20 operating days. Daily catches ranged from a low of one each on May 5, 23, and 31 to a high of twelve on May 24 and 26. A total of eighty-one (81) Northern Snakeheads were collected at the WFL in 2019. Collected Northern Snakehead lengths ranged from 17 to 27 inches. All collected Northern Snakeheads were removed from the WFL sorting tank, euthanized, and placed in the freezer at the WFL. These fish were provided to the PF&BC for the purpose of collecting biological information.

3.2 American Shad Collection

The WFL collected 390 American Shad (Table 1). The first 132 American Shad were collected on May 1. Collection of shad varied with 33.9% (132) of the shad collected on May 1, 51.0% (199) collected from May 1 to May 12, and 15.1% (59) collected from May 21 to May 31 (Table 1). On 6 of the 20 days of operation (May 6, 22, 24, 25, 28, and 31), two or less American Shad were collected. The largest number of American Shad collected at the WFL in 2019 occurred on the first day of operation, May 1 (132).

Life history information (length, weight, sex, spawning condition, scales and otolith samples) was taken from American Shad that were sacrificed, died (lift or holding mortalities), or used in spawning trials. Per 2019 operation guidelines, every twenty-fifth American Shad collected was sacrificed.

American Shad were collected at water temperatures ranging from 57.7°F to 75.0°F at Conowingo Dam's WFL and daily river flows between 40,700 and 76,600 cfs at the USGS Marietta gage station (Figure 1). The average daily river flow on the day when 132 American Shad were collected was 64,200 cfs. The average daily river flow during the operational season was 59,510 cfs.

The sex ratio of American Shad collected at the WFL is given in Table 3. Of the 390 American Shad collected, a total of 185 males and 178 females were identified at the WFL in 2019. On the twenty operational days the male to female ratio ranged from 1:0.00 to 1:2.00. Overall male to female American Shad ratio was 1:0.96. The highest number of male American Shad (50) was identified on May 1. The most female American Shad (55) identified were also collected on May 1.

The catch and effort of American Shad collected at the WFL from 1985 to 2019 is shown in Table 4. Because the total catch has dropped off in recent years, due to fewer operational days, lifts, and fishing hours; the catch per day, catch per lift, and catch per hour also decreased in 2019 from the previous three years.

Table 5 shows the operations and fish catch at Conowingo Dam WFL from 1985-2019.

A separate American Shad spawning report titled "American Shad Spawning Tests Conducted at Conowingo Dam, Spring 2019" is provided in Appendix A.

3.3 Gizzard Shad Collection

The WFL collected 220,110 Gizzard Shad in 2019 (Tables 1 and 2). Gizzard Shad accounted for 96.7% of the total fish collected. On 2 of 20 days of operation, Gizzard Shad collections exceeded 20,000 fish. Gizzard Shad collection exceeded 15,000 and 10,000 fish on 7 and 9 days, respectively. Table 1 provides the number of American Shad and Gizzard Shad collected each operational day in 2019. On days when American Shad collections equaled or exceeded 50 fish, the American Shad to Gizzard Shad ratio ranged from 1:98 – 1:427. For the days when American Shad collection is less than 50 fish, the ratio ranged from 1:528 – 1:10,588. Overall, the American Shad to Gizzard Shad ratio during the WFL operation was 1:564.

3.4 Alosines

A small number of river herring, (0 Alewife and 13 Blueback Herring) were collected during the 2019 season. One (1) Hickory Shad was collected in spring 2019. Per 2019 operation guidelines, the first 50 of each herring species (Alewife and Blueback Herring) collected were to be sacrificed followed by every twenty-fifth of each species. Length, weight, sex, scale, and otolith samples were taken from all collected river herring.

3.5 Maryland Tag-Recapture

During the 2019 season, the WFL collected no American Shad that were previously captured, floy-tagged and released downstream of Conowingo dam by the Maryland Department of Natural Resources (MDDNR). This year, the MDDNR caught 52 and tagged a total of 43 American Shad.

Per the 2019 operational guidelines, all re-captured MDDNR tagged American Shad from the current year (2019) must be returned to the tailrace below Conowingo Dam. Any MDDNR tagged American Shad collected from previous years (prior to 2019) were to be sacrificed for study. The number of floy tags observed at the Conowingo WFL in 2019 was zero. No MDDNR tagged American Shad from previous years were collected in 2019.

4.0 SUMMARY

WFL operation was initiated on May 1, river water temperature was 57.7°F (14.3°C) and daily river flow was 64,200 cfs at Marietta. The first 132 American Shad were collected on May 1 at a water temperature of 57.7°F. The WFL collected 390 American Shad from May 1 through May 31. The total number of American Shad collected during the 2019 season was the lowest collection value recorded since 1985 (390 American Shad) when the WFL was operated for trap and transport purposes (Tables 4 and 5). It is also the sixth consecutive year in which the WFL collected less than 1,000 American Shad.

Prior to the start of WFL operations in 2019, routine preseason maintenance activities were conducted, and included testing of the fish collection equipment (barrier screen, crowder doors, crowder, hopper hoist motor, and hopper door along with inspection of associated chain linkage, cables, etc.). These maintenance activities, along with routine maintenance activities performed in season resulted in no loss of fishing time due to mechanical failures during the entire fish collection season.

5.0 RECOMMENDATIONS

1) Continue to operate the WFL at Conowingo Dam per annual guidelines developed and approved by the Susquehanna River Technical Committee. Lift operation should adhere to the guidelines; however, flexibility must remain with operating personnel to maximize WFL performance and fish collection.

2) Continue to inspect weir gate cables, limit switches, and lift components to enhance season operability, and continue to evaluate effectiveness of fish sorting tank and hopper door.

6.0 LITERATURE CITED

RMC. 1983. Summary of the operation of the Conowingo Dam Lift in spring 1982. Prepared for the Philadelphia Electric Company by RMC Environmental Services, Muddy Run Ecological Laboratory, Drumore, Pennsylvania. 32 pp.

RMC. 1986. Summary of the operation of the Conowingo Dam Lift in spring 1985. Prepared for the Philadelphia Electric Company by RMC Environmental Services, Muddy Run Ecological Laboratory, Drumore, Pennsylvania. 44 pp.

RMC. 1992. Summary of the operations of the Conowingo Dam fish passage facilities in spring 1991. Prepared for Susquehanna Electric Company, Darlington, MD.

TABLES AND FIGURES

Table 1.

Daily summary of fishes collected at the Conowingo Dam West Fish Lift, 1 May - 31 May, 2019.

Date:	1-May	2-May	3-May	4-May	5-May	6-May	10-May	11-May	12-May	21-May
Day:	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY	MONDAY	FRIDAY	SATURDAY	SUNDAY	TUESDAY
Number of Lifts:	17	12	19	9	6	10	9	15	11	15
Time of First Lift:	9:30	11:30	9:50	13:00	9:15	11:40	11:00	9:15	9:25	9:15
Time of Last lift:	16:30	16:30	16:10	16:35	12:40	16:25	16:30	16:30	16:30	16:30
Operating time (hours):	7:00	5:00	6:20	3:35	3:25	4:45	5:30	7:15	7:05	7:15
Ave. Water Temperature (°F):	57.7	59.0	60.5	60.8	61.4	63.5	64.2	64.2	64.0	64.8
American Shad	132	3	59	58	52	0	8	13	6	5
Blueback Herring	0	0	0	6	0	0	0	6	0	0
Alewife	0	0	0	0	0	0	0	0	0	0
Gizzard Shad	15,750	19,150	25,175	12,200	5,100	18,475	9,500	8,050	5,525	6,630
Hickory Shad	0	0	0	1	0	0	0	0	0	0
Striped Bass	0	0	0	0	0	0	1	4	1	2
Carp	4	0	0	0	0	35	3	0	1	4
Other species	419	103	249	259	261	644	214	345	164	152
Total	**16,305**	**19,256**	**25,483**	**12,524**	**5,413**	**19,154**	**9,726**	**8,418**	**5,697**	**6,793**

Date:	22-May	23-May	24-May	25-May	26-May	27-May	28-May	29-May	30-May	31-May	**Total for**
Day:	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	HURSDA'	FRIDAY	**the Year**
Number of Lifts:	14	11	11	12	12	9	9	11	10	5	**227**
Time of First Lift:	9:15	9:15	9:15	9:15	9:15	9:45	9:20	9:30	9:45	10:30	
Time of Last lift:	16:30	16:30	16:30	16:30	16:30	16:30	16:30	16:30	16:30	13:45	
Operating time (hours):	7:15	7:15	7:15	7:15	7:15	6:45	7:10	7:00	6:45	3:15	**124:20:00**
Ave. Water Temperature (°F):	66.8	68.3	68.0	69.2	69.8	72.3	73.0	74.3	75.0	76.4	
American Shad	2	7	2	2	4	3	0	27	7	0	**390**
Blueback Herring	0	0	0	0	0	0	1	0	0	0	**13**
Alewife	0	0	0	0	0	0	0	0	0	0	**0**
Gizzard Shad	21,175	15,075	15,500	8,000	5,950	3,600	2,375	14,250	4,060	4,570	**220,110**
Hickory Shad	0	0	0	0	0	0	0	0	0	0	**1**
Striped Bass	1	3	5	3	0	2	5	3	14	6	**50**
Carp	1	4	6	5	10	111	20	645	24	255	**1,128**
Other species	221	134	242	311	329	340	642	664	221	118	**6,032**
Total	**21,400**	**15,223**	**15,755**	**8,321**	**6,293**	**4,056**	**3,043**	**15,589**	**4,326**	**4,949**	**227,724**

Table 2.

Catch of fishes at the Conowingo Dam West Fish Lift, 2019.

Number of Days	**20**
Number of Lifts	**227**
Fishing Time (hours : minutes)	**124:20:00**
Number of Taxa	**31**
AMERICAN SHAD	390
HICKORY SHAD	1
BLUEBACK HERRING	13
ALEWIFE	0
GIZZARD SHAD	220,110
STRIPED BASS	50
AMERICAN EEL	35
Carp	1,128
White Perch	987
Hybrid Striped Bass*	1
Rainbow Trout	2
Brown Trout	9
Tiger Trout*	2
Comely Shiner	30
Quillback	63
Shorthead Redhorse	660
Brown Bullhead	70
Channel Catfish	3,136
Rock Bass	45
Redbreast Sunfish	14
Green Sunfish	5
Pumpkinseed	4
Bluegill	86
Smallmouth Bass	282
Largemouth Bass	39
White Crappie	2
Black Crappie	2
Yellow Perch	7
Walleye	241
Atlantic Needlefish	36
Sea Lamprey	3
Flathead catfish	190
Northern Snakehead	81
Total	**227,724**

* Denotes hybrid fish

Table 3.

American Shad sex ratio information, Conowingo Dam West Fish Lift, 2019. No operation on 7, 8, 9, and 13-20 May 2019.

Date	Sample size	Males	Females	Male:Female Ratio
1-May	132	50	55	1: 1.10
2-May	3	1	2	1: 2.00
3-May	59	25	34	1: 1.36
4-May	58	36	22	1: 0.61
5-May	52	23	29	1: 1.26
6-May	0	0	0	N/A
10-May	8	6	2	1: 0.33
11-May	13	8	5	1: 0.63
12-May	6	5	1	1: 0.20
21-May	5	3	2	1: 0.67
22-May	2	2	0	1: 0.00
23-May	7	4	3	1: 0.75
24-May	2	0	2	N/A
25-May	2	1	1	1: 1.00
26-May	4	2	2	1: 1.00
27-May	3	0	3	N/A
28-May	0	0	0	N/A
29-May	27	16	11	1: 0.69
30-May	7	3	4	1: 1.33
31-May	0	0	0	N/A
TOTAL	**390**	**185**	**178**	**1: 0.96**

Table 4.

Catch and effort of American Shad collected at the Conowingo Dam West Fish Lift during primary collection periods,* 1985-2019.

Year	Number Days	Number Lifts	Fishing Hours	Total Catch	Catch Per Day	Catch Per Lift	Catch Per Hour
1985	37	839	328.6	1,518	41	2	4.6
1986	53	737	431.5	5,136	97	7	11.9
1987	49	1,295	506.5	7,659	156	6	15.1
1988	54	1,166	471.7	5,137	95	4	10.9
1989	46	1,034	447.2	8,216	179	8	18.4
1990	62	1,247	541.0	15,958	257	13	29.5
1991	59	1,123	478.5	13,273	225	12	27.7
1992	61	1,517	566.0	10,323	169	7	18.2
1993	41	971	398.0	5,328	130	5	13.4
1994	44	918	414.0	5,595	127	6	13.5
1995	64	1,216	632.2	15,588	244	13	24.7
1996	27	441	245.2	11,458	424	26	46.7
1997	44	611	295.1	12,974	295	21	44.0
1998	26	476	238.6	6,577	253	14	27.6
1999	43	709	312.6	9,658	225	14	30.9
2000	34	424	206.5	9,785	288	23	47.4
2001	41	425	195.1	10,940	267	26	56.1
2002	31	417	147.1	9,347	302	22	63.5
2003	31	637	171.8	9,802	316	27	57.0
2004	14	151	74.3	3,426	245	23	46.1
2005	30	295	165.9	3,896	130	13	23.5
2006	37	394	214.9	3,970	107	10	18.5
2007	29	288	135.3	4,272	147	15	31.6
2008	34	481	174.4	2,627	77	5	15.1
2009	28	282	144.1	6,534	233	23	45.3
2010	27	238	138.2	5,605	208	24	40.6
2011	15	144	85.6	3,074	205	21	35.9
2012	37	404	244.0	1,486	40	4	6.1
2013	24	288	134.1	2,030	85	7	15.1
2014	27	321	173.1	513	19	2	3.0
2015	19	194	100.5	875	46	4	8.7
2016	11	131	58.2	861	78	7	14.8
2017	13	123	56.4	736	56	6	13.0
2018	15	200	84.7	465	31	2	5.5
2019	**20**	**227**	**124.3**	**390**	**19.5**	**2**	**3.1**

*Only applies to 1985-1995 data. Excludes early and late season catch and effort when less than 10 shad/day were taken.

Table 5.

Operations and fish catch at Conowingo Dam West Fish Lift, 1985 - 2019.

Year	Number of Days	Total Fish (Millions)	Number of Taxa	American Shad	Hickory Shad	Alewife	Blueback Herring
1985	55	2.318	41	1,546	9	377	6,763
1986	59	1.831	43	5,195	45	2,822	6,327
1987	60	2.593	43	7,667	35	357	5,861
1988	60	1.602	49	5,169	64	712	14,570
1989	53	1.066	45	8,311	28	1,902	3,611
1990	72	1.188	44	15,964	77	425	9,658
1991	63	0.533	45	13,330	120	2,649	15,616
1992	64	1.560	46	10,335	376	3,344	27,533
1993	45	0.713	37	5,343	0	572	4,052
1994	47	0.564	46	5,615	1	70	2,603
1995	68	0.995	44	15,588	36	5,405	93,859
1996	28	1.233	39	11,473	0	1	871
1997	44	0.346	39	12,974	118	11	133,257
1998	41	0.575	38	6,577	6	31	5,511
1999	43	0.722	34	9,658	32	1,795	8,546
2000	34	0.458	37	9,785	1	9,189	14,326
2001	41	0.310	38	10,940	36	7,824	16,320
2002	31	0.419	35	9,347	0	141	428
2003	31	0.147	30	9,802	1	16	183
2004	14	0.039	30	3,426	0	0	1
2005	30	0.094	36	3,896	0	0	0
2006	37	0.163	38	3,970	0	2	6
2007	29	0.159	36	4,272	0	7	153
2008	34	0.733	37	2,627	0	2	7
2009	28	0.226	39	6,534	4	20	165
2010	27	0.158	36	5,605	1	1	81
2011	15	0.100	32	3,074	0	0	0
2012	37	0.322	38	1,486	0	0	7
2013	24	0.489	33	2,030	0	0	2
2014	27	0.597	33	513	0	13	233
2015	19	0.242	29	875	0	29	17
2016	11	0.179	25	861	0	20	14
2017	13	0.177	29	736	0	5	0
2018	15	0.315	29	465	3	6	21
2019	**20**	**0.228**	**31**	**390**	**1**	**0**	**13**

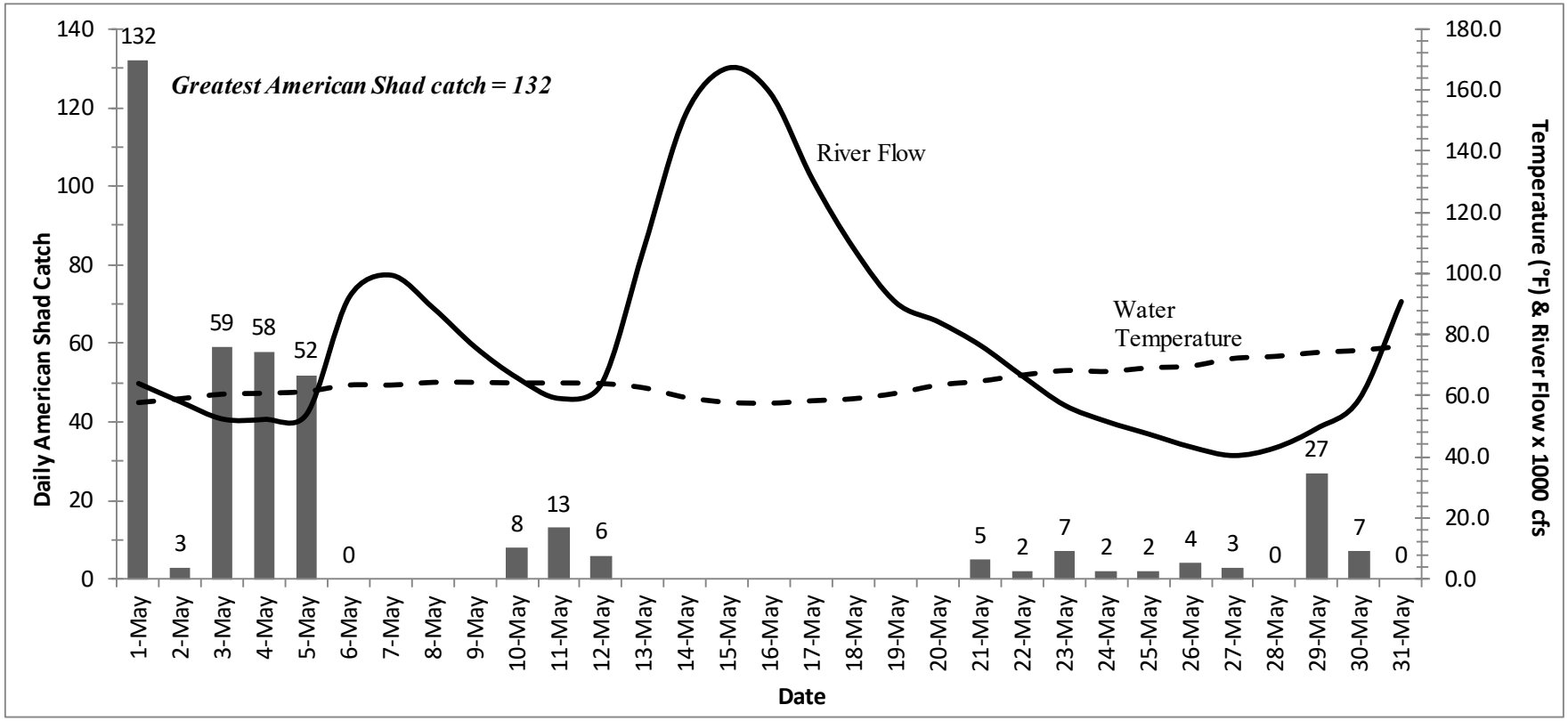

Figure 1 A plot of river flow (x 1000 cfs) as recorded at Marietta and water temperature (°F) recorded at Conowingo Dam versus the daily American Shad catch at the West Fish Lift, Spring 2019. The West Lift was not operated on 7, 8, 9, and 13-20 May 2019.

APPENDIX A
AMERICAN SHAD SPAWNING TESTS CONDUCTED AT CONOWINGO DAM, SPRING 2019